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## VESICULAR STOMATITIS OF HORSES AND CATTLE

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### HISTORY AND CHARACTERISTICS

Vesicular stomatitis is known in Europe and South Africa, and has been observed occasionally in sporadic form in the United States, but without attracting any particular attention. During the early fall of 1916, however, it became very extensive in certain sections of this country, being especially prevalent in Nebraska, South Dakota, Colorado, and Wyoming. It was first reported among the horses and mules at remount stations in the Central West, where large numbers of animals had been collected prior to shipment to Europe for use in the French and British Armies. Here the disease found ideal conditions for its spread among thousands of these animals closely quartered in barns and pens. From these remount stations in the Central West the disease became distributed by following the channels of trade from the westward markets eastward as far as the Atlantic coast. The affection did not stop even there, as several shipments were made abroad while the horses were in the incubative stage of the disease, and infected American horses were found shortly after arrival in France.

Strange as it may seem, the first information that this country was experiencing an outbreak of vesicular stomatitis was reported in an article by the French veterinarian Jacoulet, which appeared in the *Recueil de Médecine Vétérinaire*, December 30, 1915. Owing to the difficulties attending the delivery of European periodicals during the recent war this copy was not received until several months later. Jacoulet referred to the erosive stomatitis of indeterminate nature affecting horses coming from America for the French Army.



He indicated that some of the veterinarians coming to the army depot were acquainted with this disease, calling it stomatitis of horses and attributing it to the fact that the new horses frequently licked the freshly whitewashed walls near them. The question of etiology was at once referred to the Pasteur Institute, but at that time attempts to carry the disease from horse to horse proved unsuccessful. The opinion was thereupon advanced that defective feed probably of a mycotic nature was responsible, especially since moldiness was quite extensive in American baled hay brought over with the horses.

In the issue of the above-named French journal dated February 29, 1916, Vigel records having observed the disease in question in a large number of American animals. On the basis of his observations he believed that the cause of vesicular stomatitis is a contagion and should not be looked for in the poor quality of hay, as the disease spread to French horses on the surrounding farms and these animals had never eaten American hay. At least one cow became similarly affected. Three bacteriologists of the French Army took samples of blood and vesicular fluid from infected horses, but their results were likewise negative. However, Vigel proved quite clearly that the disease is contagious and transmissible through direct inoculation. More recently, May 15, 1917, Panisset reports in the *Revue Générale de Médecine Vétérinaire* that vesicular stomatitis had gained considerable ground during the previous few months, but not sufficient to cause any alarm. Particularly those depots that received horses coming from the first infected remount stations have paid heavy tribute to the affection. Although known and described in France before the World War, it had been observed only occasionally, and its frequency there in 1917 was considered by Panisset to be due to importations of infected American horses for military purposes.

Notwithstanding that the disease primarily affects horses and mules, it may spread to cattle under appropriate conditions, but thus far it has not been observed under natural conditions among hogs and sheep. Evidently the necessary conditions for its spread from horses to cattle existed in Nebraska, as a shipment of cattle from that locality to the Kansas City Stock Yards in the fall of 1916 was found infected. Much excitement was occasioned thereby, as the disease was quite suggestive of foot-and-mouth disease. However, a series of careful experiments was at once begun, from which the true nature of the disease was ascertained and the diagnosis of vesicular stomatitis made.

Among other more important forms of stomatitis may be mentioned mycotic stomatitis of cattle, which results from eating feed containing irritating fungi; necrotic stomatitis, especially affecting calves and pigs, which is caused by infection with the necrosis bacillus; stomatitis contagiosa, or foot-and-mouth disease, which is one of the most highly infectious diseases of livestock and caused by a filterable virus; and pustular stomatitis, which is less contagious in character than the former and confined solely to the equine.

Concerning vesicular stomatitis, the name not only indicates the location of the lesions in the mouth but also suggests that the vesicles or blisters are characteristic features, being observed at the beginning of the disease. Other names which have been applied to this affection are sporadic aphthæ, stomatitis vesiculosa, stomatitis



apthosa, erosive stomatitis, sore mouth, "blue tongue," and pseudo foot-and-mouth disease.

### ETIOLOGY

Vesicular stomatitis is caused by a filter-passing virus, which has been shown to pass through such bacteria-retaining filters as the three grades of Berkefeld, designated by the letters V, N, and W, and of the Chamberlain, known as L 3 and L 7.

The virus is contained in the contents of vesicles which develop in the course of the disease in the epithelium covering them and also in the blood during the febrile stage and for a short period following. It has not thus far been demonstrated to occur in the milk of cows except as a contaminant from vesicles, which sometimes form on the teats. However, the work done to determine this has not been sufficient to lead to conclusive results. The virus disappears from the mouth of the affected animals within a few days after the rupture of the vesicles.

Though little work has been done to determine the resistance of the virus to sunlight, drying, and disinfectants, the indications are that it is rapidly destroyed by these means. However, fragments of the epithelial coverings of vesicles kept in a moist state either in 50 per cent glycerin or without it, placed in test tubes, sealed with paraffin, and kept in the dark in the ice box, have been found in some instances to contain active virus at the end of a month.

Virus kept alive for more than four years, by successive passages through guinea pigs, still appeared to have lost little of its virulence. On the other hand, the disease often appears to die out in naturally infected herds without infecting more than a small proportion of the animals.

### PLURALITY OF TYPES OF VIRUS

In 1925 the Bureau of Animal Industry discovered the existence of two types of vesicular stomatitis in the United States, which appear to be indistinguishable clinically, just as there has been found to be three types of foot-and-mouth-disease virus in Europe. The general characteristics of the two viruses seem to be the same, but one type of virus does not immunize against the other, although it does against itself. An animal recovering from one type might suffer from a fresh attack of the disease caused by the other within a few weeks, whereas it would be immune to the same type for months and possibly years.

One of the two types of virus was found to be responsible for an outbreak of vesicular stomatitis in the Middle West early in 1925, another in New Jersey late in 1925, and a third outbreak in Alabama in 1929.

### PATHOGENICITY

Under natural conditions the disease is transferable to cattle, horses, and mules, but in the several outbreaks of the disease that have occurred in this country no hogs or sheep have been observed to have become affected with the disease through natural exposure. Hogs, however, may be infected by inoculation, as may also guinea pigs, but the latter likewise do not contract the affection by natural exposure.



Burton<sup>1</sup> in describing a disease under the name stomatitis contagiosa of horses, but which appears to be identical with vesicular stomatitis, reports that mules, though by no means immune, are not so susceptible as horses and that the affection is transmissible to man. He cites three cases of human infection, one of which was himself. However, vesicular stomatitis has not been reported in man in North America, and mules have not been observed to be less susceptible than horses.

### SYMPTOMS AND LESIONS

The first phenomenon of vesicular stomatitis consists in the formation of reddened patches on the buccal mucosa, especially of the tongue. These are quickly succeeded by vesicles or blisters of grayish-red color only slightly elevated and of various sizes from a dime to a silver dollar, filled with clear or yellowish serous fluid. These blisters may be isolated, but frequently they coalesce to form a large vesicle. They usually rupture in a very short time, which accounts for their not being recognized at times even in the early stages of the disease. The rupture of the vesicles results in exposing the raw underlying surfaces, which appear as reddened erosions with the grayish-white fragments of the torn mucous membrane of the preexisting vesicles still attached to the irregular borders like a fringe. These erosions may become confluent, varying from the size of a dime to that of the palm of the hand, and may even involve practically the entire upper surface of the tongue in horses. Healing varies, but usually occurs quite rapidly in from 8 to 15 days in uncomplicated cases.

While these lesions in horses are principally confined to the upper surface of the tongue, they may involve the inner surface of the lips, the angles of the mouth, and the gums. In cattle lesions may occur on the tongue, hard palate, lips, and gums, sometimes extending to the muzzle and around the nostrils. Often the lips of the horse are swollen and itchy, which causes the animal to rub the muzzle against any near-by object. In a very few cases fresh cows have shown similar lesions on the teats when their infected calves have been sucking them.

In one outbreak in which the disease seemed to be of unusual virulence and infected more than 30 herds, a large proportion of the cows in three dairy herds developed large vesicles on the teats, the virus evidently being carried on the hands of the milker from cow to cow. In none of the affected cows were vesicles observed on the udder proper.

While foot lesions were reported to occur in horses by Capt. A. C. Burton, of the English Army Veterinary Corps, in 1917, and while they have been produced by bureau investigators in the feet of both horses and cattle in a few cases by inoculation, no lesions on the feet, in either of these animals, due to natural infection, were observed in the United States in the outbreaks occurring before 1925. Since then, however, a few cases in which foot lesions developed in cattle have been observed in the field. In nearly all of these cases the

<sup>1</sup> BURTON, A. C. "STOMATITIS CONTAGIOSA" IN HORSES. *Vet. Jour.* (n. s. 24) 73: 234-242, illus. 1917.



lesions were confined to a single foot of the affected animal. The lesions consisted of a very large vesicle in the interdigital space, extending over its entire area. Other vesicles appeared around the coronet. In some of the affected feet observed there was considerable separation of the horny from the deeper structures at the heels. The lesions of the feet were practically identical in appearance with those of foot-and-mouth disease, but, unlike them in the cases observed, were confined to one foot. Furthermore, only a very small proportion of affected animals had lesions of the feet, whereas in foot-and-mouth disease the feet, as well as the mouth, usually become affected.

Immediately before or simultaneously with the appearance of the vesicles, the animal is usually depressed and there is present a rise of temperature, which rapidly subsides after the vesicles rupture. A more or less profuse flow of saliva follows, which dribbles from the lips and consists of a thin, stringy, or frothy fluid. Not infrequently the presence of salivation is the first indication that the animal is sick. Owing to the painful condition of the mouth at this stage, there is loss of appetite or at least inability to eat, and in horses "gritting" of the teeth is quite frequent, while in cattle "smacking" noises are heard as in foot-and-mouth disease. This sensitiveness as a rule remains for several days, after which healing commences, and it is remarkable to observe how quickly the sick animals will begin to eat even while their tongues are still eroded. Although eating well, they do not regain their original thrifty appearance for some time longer. In dairy cows in addition to shrinkage in flesh there is a noticeable reduction in the normal flow of milk for a few days.

So far as observations of the writer are concerned, the period of incubation of vesicular stomatitis, following natural exposure, varied from 36 hours to 9 days, but the greatest number of cases occurred in from 2 to 5 days after exposure. Following inoculations, vesicles are seldom more than 48 hours in appearing, are usually present after 38 to 44 hours, and occasionally appear in 24 hours. The temperature begins to rise between the eighteenth and twenty-fourth hours and may reach 105° or even 107° F. in cattle.

No losses have been reported from uncomplicated cases of this disease in either horses, mules, or cattle. A certain proportion of horses and mules having vesicular stomatitis also became infected with either influenza or contagious pneumonia, or perhaps both, and some deaths have occurred among such animals.

### CONTAGIOUSNESS

The degree of contagiousness varies between wide limits. In fact, certain writers have claimed that it is not contagious, because they fail to reproduce the disease after experimenting with only one healthy animal. The writer's experience with this disease shows that unless the inoculation is made from a freshly ruptured vesicle frequently one or even more of the inoculated animals in an experiment will fail to develop the infection, as in several instances the disease was produced in only 2 out of 3, or 2 out of 4, or, again, 3 out of 9 of the experimental animals; so that it is necessary to use more than one animal if accurate information is to be obtained. This



point is strongly brought out by the opposite conclusions reached by the two French investigators, Jacoulet and Vigel, who found the disease in American horses shipped to France. The former believes the disease is benign, nontransmissible, and of alimentary origin, while the latter readily transmitted the disease to other horses and convinced himself of its contagiousness.

Experiments have proved that the disease is most readily transmissible at the time the blisters rupture or shortly thereafter, but when the lesions are 5 or 6 days old the virus of the disease has practically disappeared. This may account for the greatly differing results investigators have had in their attempts to transfer the disease artificially. These facts show the necessity of using several experiment animals for inoculation, and also of injecting the infectious material as soon as possible after the blisters have formed.

The virus is evidently of short life. The disease usually is transmitted only by close contact, and it is probable that infected environment may remain dangerous longer than the infected animal. At the Bureau of Animal Industry Experiment Station, at Bethesda, Md., a young bull was placed in close association with two cattle in a pen 14 by 16 feet, 5 days after the rupture of vesicles in his mouth, without transferring the disease to the healthy animals. However, when an animal in the early stages of the disease was placed with these two cattle and allowed to remain until the vesicles ruptured, both developed the disease, one on the fourth day and the other on the eighth day after rupture of vesicles in the mouth of the exposing animal. In other experiments, horses and cattle were placed in a field, set aside for animals that had recovered, 3 weeks after they first showed symptoms of disease and a day or two less than this after rupture of vesicles. Healthy cattle placed with these animals developed no disease. Likewise, susceptible animals turned into a stable which 3 weeks previously, in one instance, and 16 days previously in another, had harbored active cases of vesicular stomatitis, remained well. In another experiment, a heifer was tied in an uncleaned stall immediately after it had been vacated by an animal which 5 days previously was in the active stage of the disease, vesicles having just ruptured. In still another, a cow was similarly placed in a stall immediately after another cow in which vesicles had ruptured in her mouth 53 hours earlier had been removed. Both of these animals failed to contract the disease. As proof that their failure to do so was not because they were immune, both were later inoculated with virus and contracted the disease. Several instances have been reported in which a line fence or a board fence in a double corral has been sufficient to prevent transmission of the disease from the infected animals on one side to the healthy animals on the other.

Investigations indicate that the disease is very seldom communicated by owners or caretakers of affected animals visiting other farms. As a rule the disease appears to spread by direct contact with recently affected animals, or by recently infected feed troughs, water troughs, bridles, or pails. However, in one outbreak, in which the virus seemed to be unusually virulent, the disease appeared to spread in some other way in addition to these, possibly by a person who visited infected herds and then handled susceptible cattle. In this



outbreak, which lasted about a month, 33 herds, containing in all approximately 700 animals, became infected. Inoculation experiments on such laboratory animals as rabbits, rats, and mice have resulted negatively, but guinea pigs can be regularly infected by inoculation through scarification on the metatarsal pads, and less so by intra-abdominal injection. Attempts, however, to infect them by natural exposure have not been successful. The disease manifests itself in susceptible animals more rapidly after the application of infectious material to scarified areas in the mouth than through intravenous injection, although positive results have been obtained also by the latter method. Inoculations made on the upper surface of the tongue are more likely to take than if made elsewhere. The freshest material that it is possible to obtain should be used in making the inoculations.

Contrary to experiences in the field, the bureau was able in several test inoculations to transmit infection to the feet of cattle in a small proportions of cases, and likewise also produced lesions in from 5 to 9 days in the feet of one hog, in the mouth of another, and on the snout of the third. While these cases were the exception and not the rule, they should be recorded for their scientific interest. In this connection it should be stated also that a number of hogs in immediate contact with these animals but without receiving any artificial inoculation remained normal in all cases, while a number of cattle similarly exposed contracted lesions which were confined solely to the mouth.

### IMMUNITY

An attack of the disease caused by one of the two known viruses has been shown to protect one lot of guinea pigs against an inoculation with the same strain of virus for at least a year, and another lot 2 years, but does not afford protection against the other virus. A number of horses and cattle which were typically affected at the bureau experiment station failed to contract the disease when inoculated with the virus 3 months later, although the control animals became infected promptly. In these cases immunity had persisted for at least 3 months. Further tests regarding its duration could not be made at the time because the required infectious material was not obtainable, since the disease had disappeared. More recently three cows that had recovered from an attack of the malady failed to develop it again 5, 7, and 7½ months, respectively, later, when inoculated with virus proved to be virulent. Still more recently (1930) two cows that had had the disease 4 years and 7 months previously resisted an exposure through inoculation which caused the disease to develop in two susceptible cows and two guinea pigs inoculated with the same material.

The results of these tests, though made on a limited number of large animals, coupled with the fact that guinea pigs remain immune for a long time following an attack of the disease, indicate that immunity in cattle, and also likely in horses, is fairly lasting.

Whether the milk of affected cattle is or is not infectious for people has not been recorded, but such milk has been fed experimentally to hogs without producing any ill effects.



## DIFFERENTIAL DIAGNOSIS

While the disease has not the great economic importance of foot-and-mouth disease, it nevertheless is contagious and causes considerable alarm owing to its close resemblance to the dreaded European disease. Furthermore, as most writers state, this infection in cattle may be readily confounded with foot-and-mouth disease, and experience has shown that a prompt and exact differentiation is accompanied with numerous difficulties. The real difficulties surrounding the diagnosis are best appreciated by those who have faced them with the consciousness that their pronouncement if mistaken would lead on one hand to unnecessary and serious economic disturbances and on the other hand to the spread of one of the most dreaded and easily communicated among animal plagues. Vesicular stomatitis therefore will prove a menace whenever and wherever it may reappear. For these reasons it is strongly urged that local quarantines to prevent its spread be imposed by State livestock officials in whose territory the disease may be found. All owners and handlers of horses, mules, and cattle, particularly liverymen, managers of stockyards, and stockmen, should be directed to separate sick from well animals, clean and disinfect contaminated premises, and have all infected animals appropriately treated.

The opinion that the malady is not foot-and-mouth disease is based on the fact that persistent observation of sick animals has failed to reveal certain typical symptoms which would be expected in an outbreak of foot-and-mouth disease. The drooling, vesicles, and erosions are similar in appearance to those produced by foot-and-mouth disease, but animals in the field rarely show soreness of the feet, which is a common symptom of foot-and-mouth disease. Moreover, many horses have this particular ailment, but horses have not been observed to contract foot-and-mouth disease in any of the previous foot-and-mouth outbreaks in the United States. Hundreds of hogs exposed to the disease and in association with the sick animals in pastures have shown no signs of the malady, which is regarded as significant, because in the 1914 outbreak of foot-and-mouth disease hogs were as susceptible to that disease as were cattle. Exposed sheep also failed to show vesicular stomatitis, yet these cloven-footed animals are susceptible to foot-and-mouth infection. In a number of cases of vesicular stomatitis the lesions appeared to be continuous or progressive, and not explosive, as in foot-and-mouth disease. In these instances secondary lesions were apparent on a number of consecutive days in the mouths of both horses and cattle, and vesicles were observed on the bases of tongues whose free portions were almost denuded of mucous membrane as a result of the rupture of similar vesicles six or seven days before.

Complications are extremely rare in vesicular stomatitis, and mammitis and chronic diseases of the hoof following vesicular stomatitis, are unusual. Sucking calves are seldom affected with the disease, and rarely in other than a mild form, while an attack of foot-and-mouth disease in calves is always serious and not infrequently fatal. The vesicles in foot-and-mouth disease as a rule are larger than in vesicular stomatitis, and are more tightly filled with serous fluid, but in many cases are, in appearance, indistinguish-



able from them. Furthermore, instead of increasing in virulence as it passes through the herd and infecting practically every animal in it, vesicular stomatitis tends to die out before it has infected a very great proportion of them.

The percentage of animals infected in each of the herds of cattle, and the history of exposure without transmission of the disease except by immediate contact, would indicate that this ailment is not the highly contagious foot-and-mouth disease which, once it is introduced into a herd, quickly affects practically 100 per cent of the cattle and hogs on all the farms to which the virus may be carried by intermediate agencies.

The result of this study of vesicular stomatitis suggests the necessity of inoculating horses with suspected material in any future outbreak of disease bearing a resemblance to foot-and-mouth disease, as this appears to be the only present method of promptly differentiating between it and vesicular stomatitis.

Finally, it must be apparent that vesicular stomatitis is a disease more closely resembling foot-and-mouth disease than either mycotic or necrotic stomatitis, and that Huttyra and Marek are correct in their opinion that a reliable differential diagnosis can be made only after inoculation experiments and careful observation lasting a number of days.

In mycotic stomatitis portions of the lining membrane of the mouth become inflamed, and in a few days it changes to a croupous membrane which peels off, leaving a raw surface, while the thin skin between the toes may also be inflamed. Swelling of the feet and stiffness of the animal are frequently evident in mycotic stomatitis. The previous history of the case, the absence of its spread to horses exposed to the infection, and the complete negative results obtained by the inoculation of calves, distinguish between this disease and vesicular stomatitis. Lastly, mycotic stomatitis occurs in only from 10 to 15 per cent of the cattle in a herd, usually late in the summer or early in the fall after a dry spell, and it does not run a regular course.

Necrotic stomatitis may be distinguished from vesicular stomatitis by the fact that while it affects cattle and especially calves, it may also involve pigs and sheep, but its spread among the animals of a herd shows a much lower degree of infectiousness than vesicular stomatitis. The characteristic lesion of the latter is the appearance of blisters containing a serous fluid on the mucous membrane of the mouths of the affected animals. In necrotic stomatitis blisters are never formed, destruction of the tissues occurring from the beginning and being followed by the formation of yellowish, cheesy patches principally found involving the lining membrane of the mouth, especially the tongue and cheeks. The cause is *Actinomyces necrophorus* (*Bacillus necrophorus*).

In horses vesicular stomatitis must be differentiated from contagious pustular stomatitis, and this is not difficult. In the latter disease there are no simple erosions, but instead there are raised nodules on the mucous membrane of the mouth. These nodules suppurate and liquefy in the center, causing the conical surfaces to slough, resulting in the formation of pustules or ulcers, from which the name of the disease is derived. The location of the



nodules and pustules is chiefly on the lips, gums, inside of the cheek, and on the tip and sides of the tongue. While the disease may be transmitted artificially to cattle, sheep, and hogs it occurs under natural conditions only among equines.

### TREATMENT

The treatment of vesicular stomatitis consists in first removing the affected from the healthy animals and isolating the former until fully recovered. Such isolation, together with the adoption of rigid sanitary precautions, greatly reduces the prevalence of the disease. Medicinal treatment or undue handling of the affected parts should not be attempted until after the true nature of the disease has been determined, as the lesions may be so mutilated as to make diagnosis difficult. If it is found that the animals are affected with vesicular stomatitis and they are gentle enough to be handled, one-half tablespoonful of borax should be placed on the tongue twice daily, or the mouth syringed several times a day with a 1 per cent solution of permanganate of potassium; otherwise 2 heaping tablespoonfuls of borax or 1 tablespoonful of potassium chlorate should be dissolved in a bucket of water and the affected animals allowed to drink or rinse their mouths with this medicated water at their pleasure. Hay should not be fed for the first few days, but instead bran or other soft feed should be given. If the animals are treated in this manner and carefully fed, the disease should rapidly disappear.





